Super KEKB
IR Vacuum Chamber and IR Installation

From a disassembling scene of Belle
PR office Photo Gallery

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Ken-ichi Kanazawa

KEKB Vacuum Group

IR Technical Meeting Member

IR Installation Meeting Member

SVD/IR Mechanics Meeting Member

Contents

0. Sketch of IR

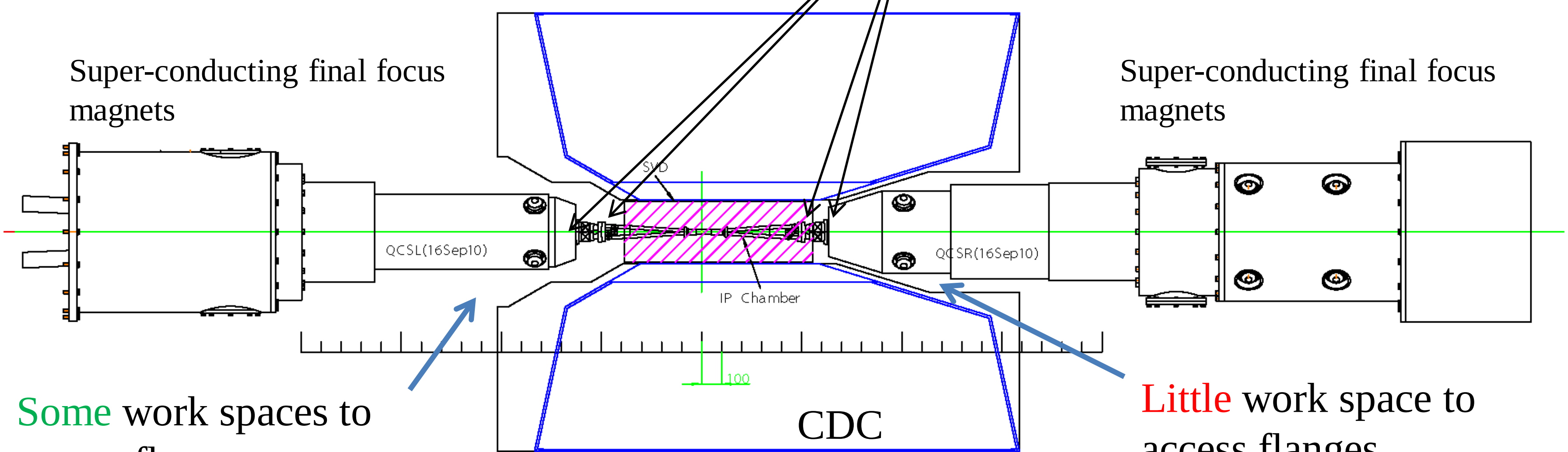
- IP chamber is supported by the SVD frame.
- SVD is supported by CDC.
- QCS cryostats can move out.

Connection flanges for vacuum chambers.

Top view

Super-conducting final focus magnets

Super-conducting final focus magnets



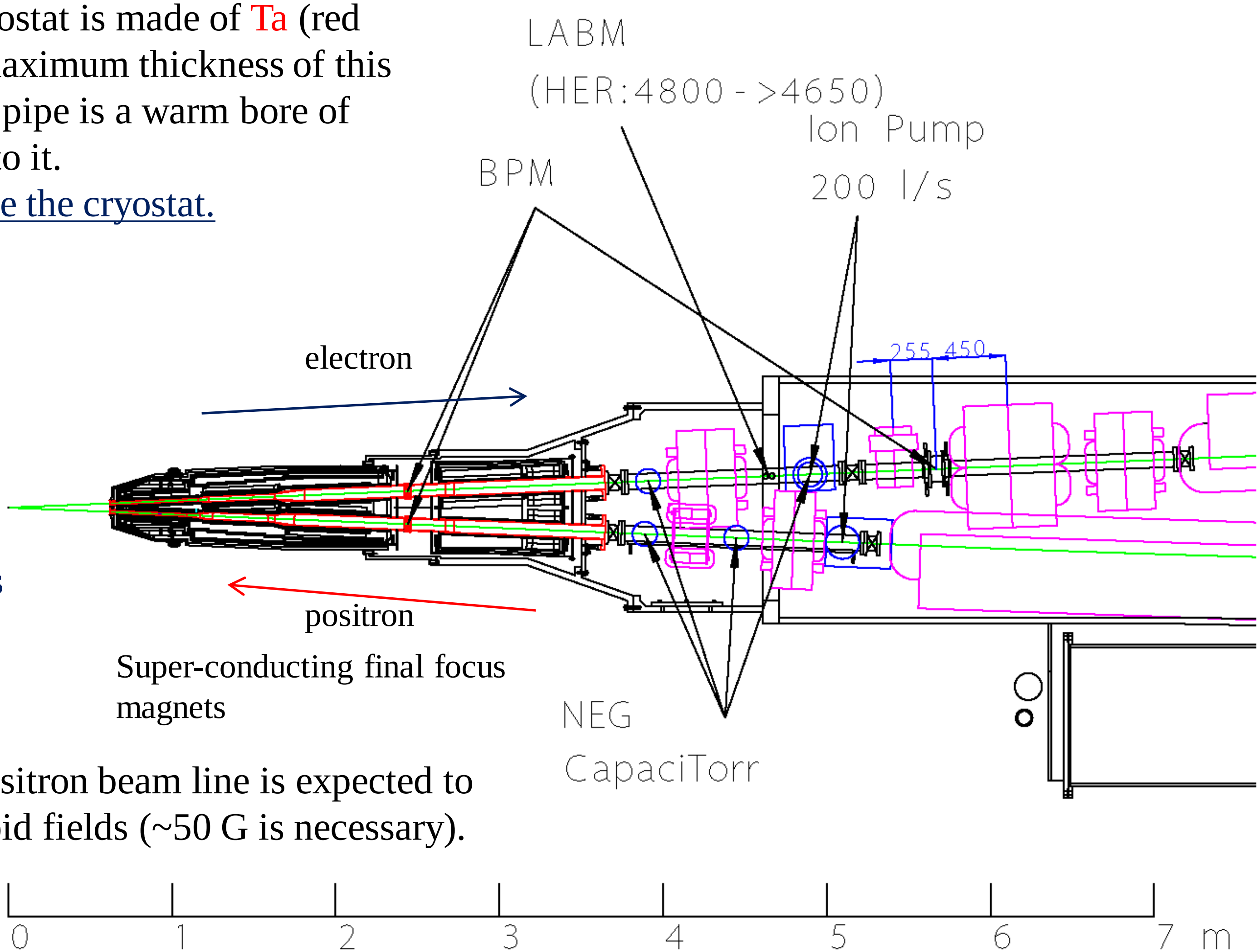
Some work spaces to access flanges.
It will be possible to make use of these spaces.

Little work space to access flanges.
It is impossible to connect flanges in this configuration.

1. Layout of Vacuum Components R side

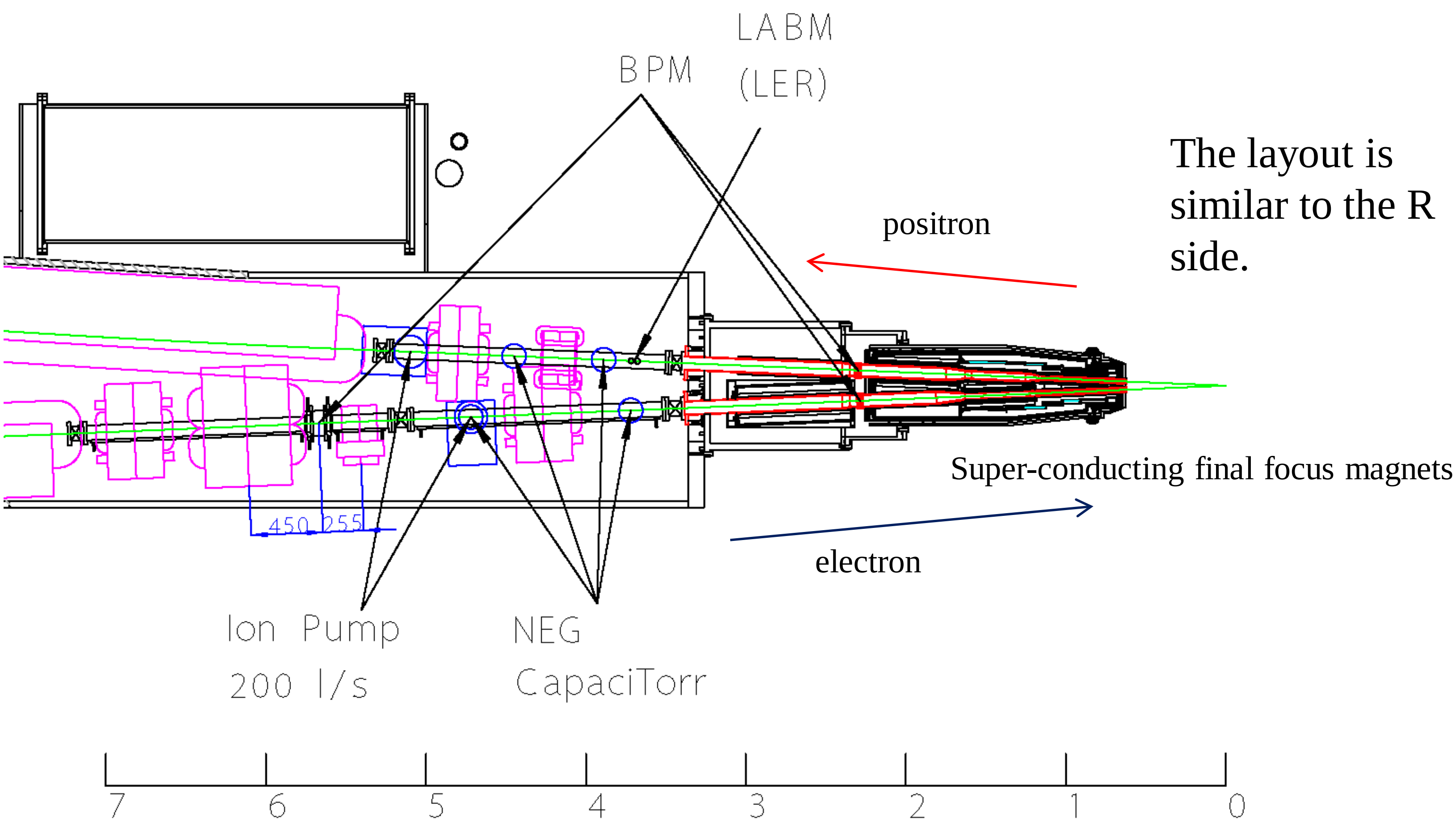
The beam pipe in the cryostat is made of Ta (red part in the figure). The maximum thickness of this pipe is 4 mm. This beam pipe is a warm bore of the cryostat and is fixed to it.
Pumps are located outside the cryostat.

The major gas load for the incoming positron line is photon-desorbed gas. That for the outgoing electron line is thermal outgassing.



Electron cloud in the positron beam line is expected to be suppressed by solenoid fields (~50 G is necessary).

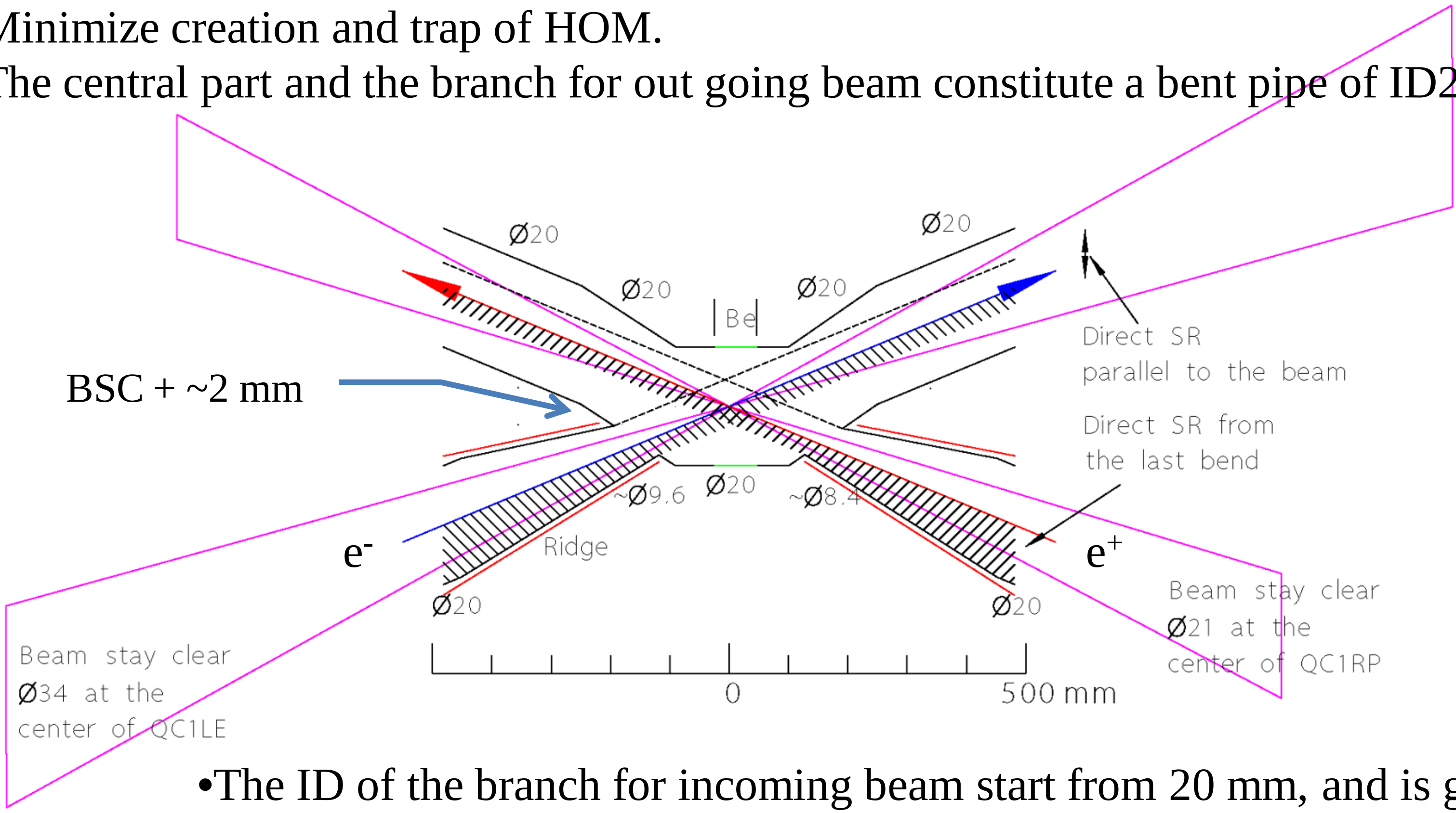
1. Layout of Vacuum Components
L side



The layout is similar to the R side.

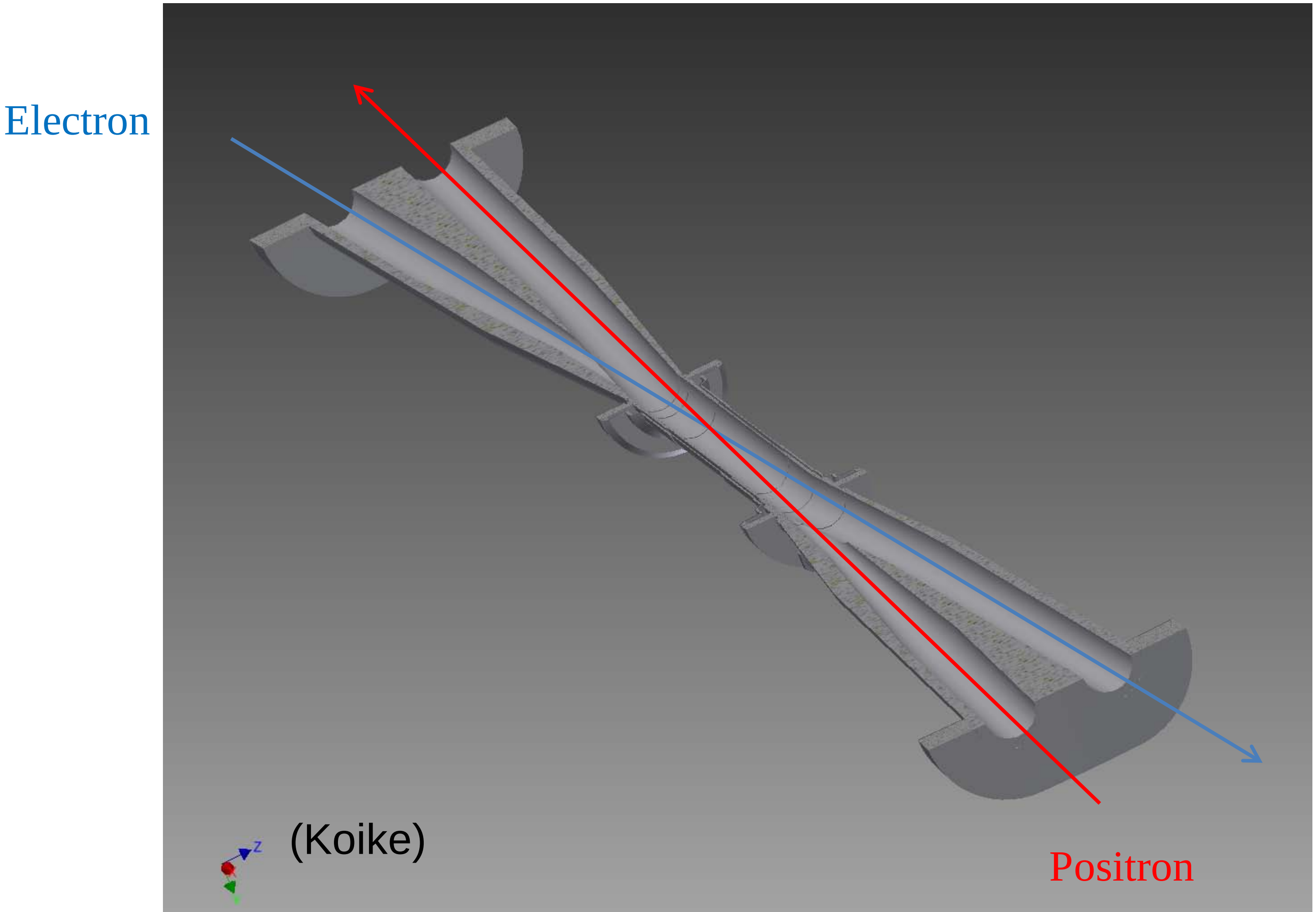
2. IP Chamber Shape

- Minimize creation and trap of HOM.
- The central part and the branch for out going beam constitute a bent pipe of ID20 mm.



- The ID of the branch for incoming beam start from 20 mm, and is gradually reduced to about 9 mm to stop direct SR.
- The inner surface of the branch for incoming beam has ridges to prevent scattered light from hitting the central Be part.

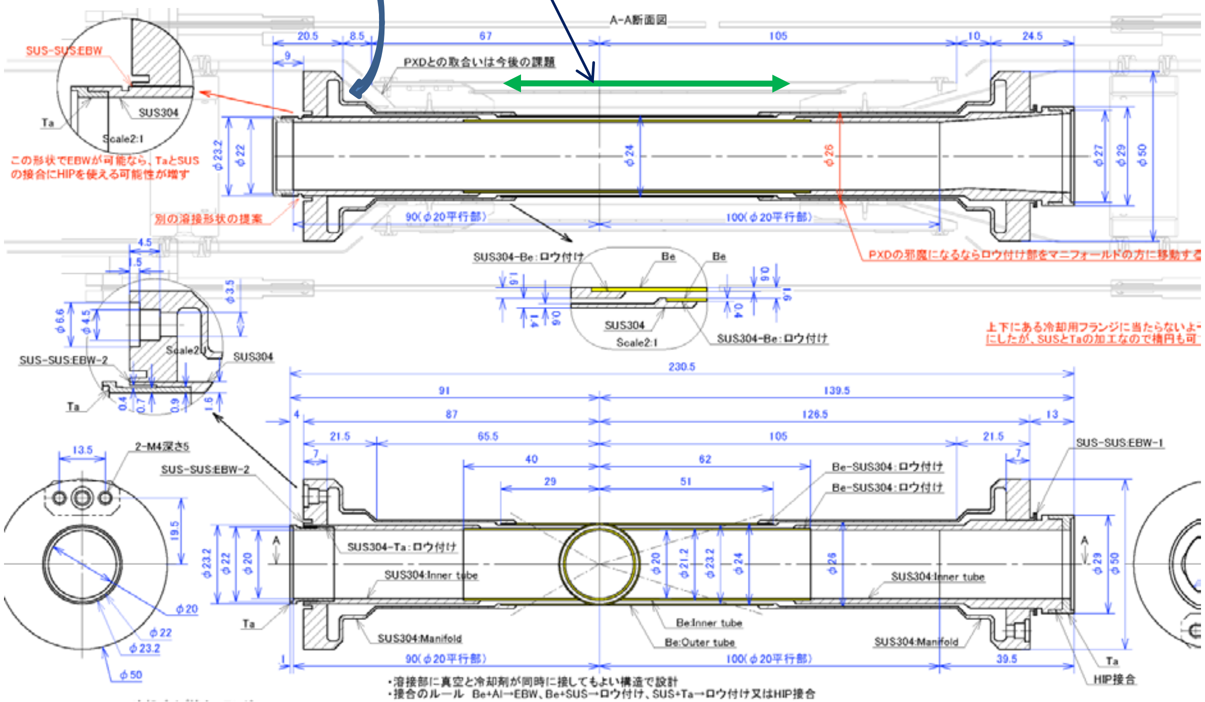
2. IP Chamber
Cut View



2. IP Chamber Central Part

Diaphragm to absorb the change of the length of Be pipes.

Double Be pipe



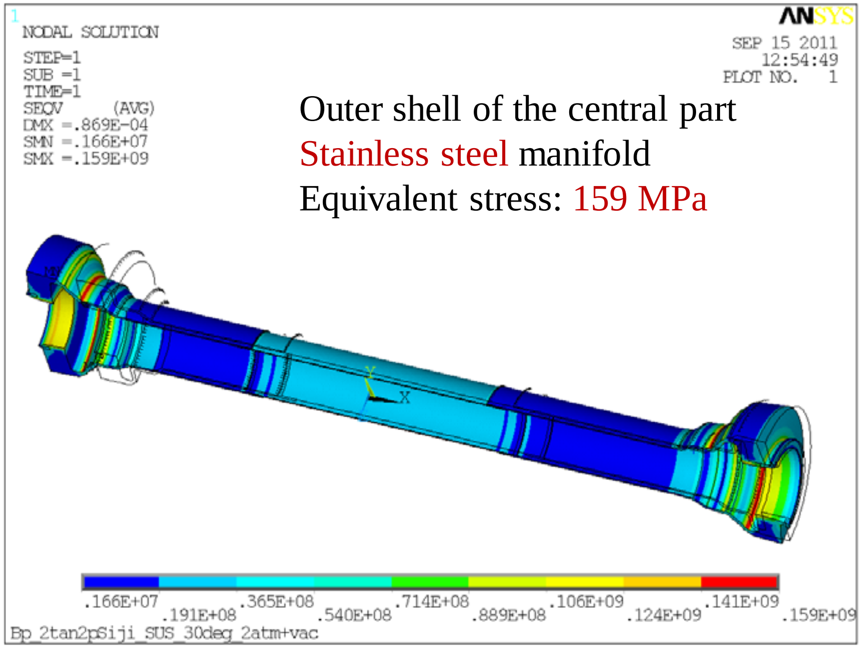
(Kohriki)

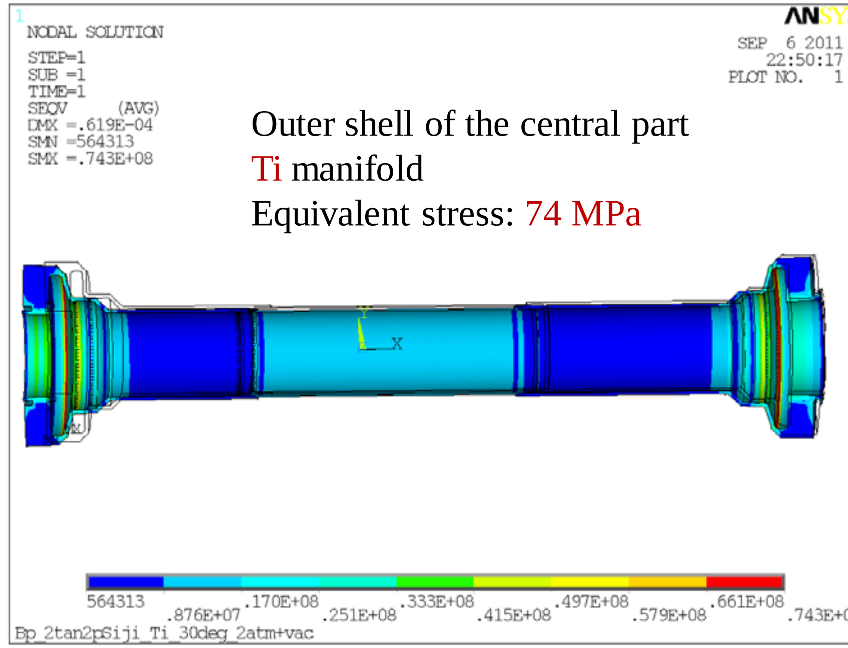
Mock-up model for cooling test

- The middle of the central part is a double Be pipe. The gap between pipes is a space for a coolant.
- The coolant is paraffin. The flow of paraffin can absorb a heat of ~270W for a temperature rise of 10℃. (Estimated heat load from the beam is less than 100W.)
- In this design, it is permitted to put a weld seam between paraffin and vacuum.
- Both ends of the double Be pipe are brazed to manifolds made of Ti (good spring action).
- A vacuum surface of Be is coated with 10~20 μm Au to stop 5~20 keV photons.

2. IP Chamber
Stress analysis (1)

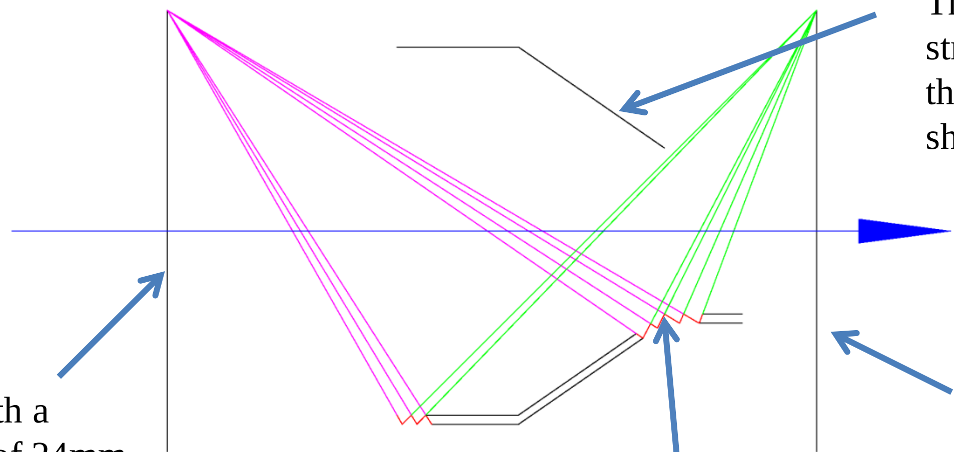
(Koike)





- Specification: No dangerous stress under the temperature difference of 30°C between the inner and the outer Be pipe.
- The temperature causes an equivalent stress of 159 MPa in a stainless steel manifold, which is about 80% of the yield strength of stainless steel (206 MPa).
- Therefore Ti is adopted instead of stainless steel for the manifold. The equivalent stress for Ti under the same condition is 74 MPa while the yield strength of Ti is 170 MPa.

2. IP Chamber
Ridge shape (1st idea)



Thin wall around here cannot has a ridge structure. However, scattered photons from this part enter the central pipe with a shallow angle and give no serious effect.

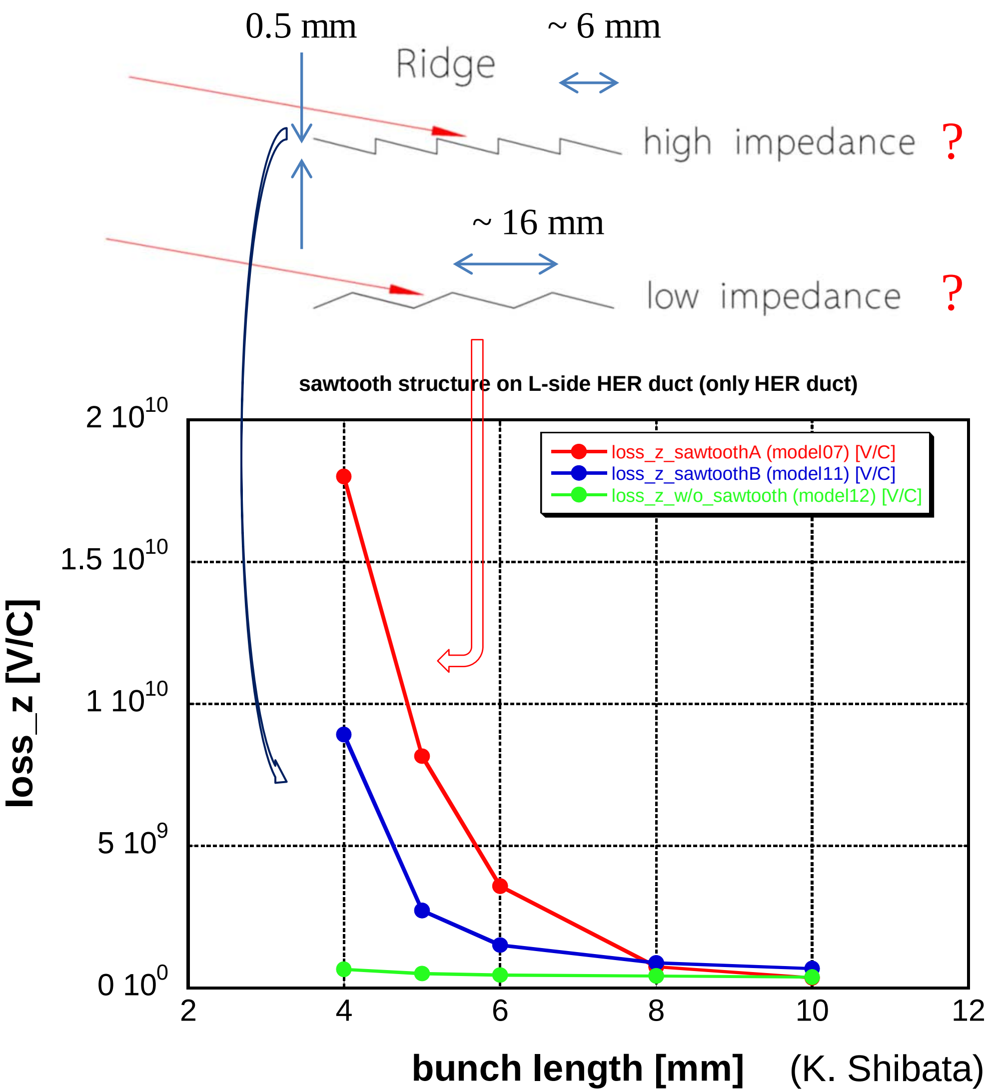
A disk with a diameter of 24mm in front of the Be pipe.
This disk should be free from scattered photons.

A disk with a diameter of 24mm. The position is the nearest end of a photon production region.

The narrowest aperture must be a ridge, of course.

Only single scattering is taken into account.

2. IP Chamber
More effective ridge?



Low risk for multiply scattered photon to escape forward

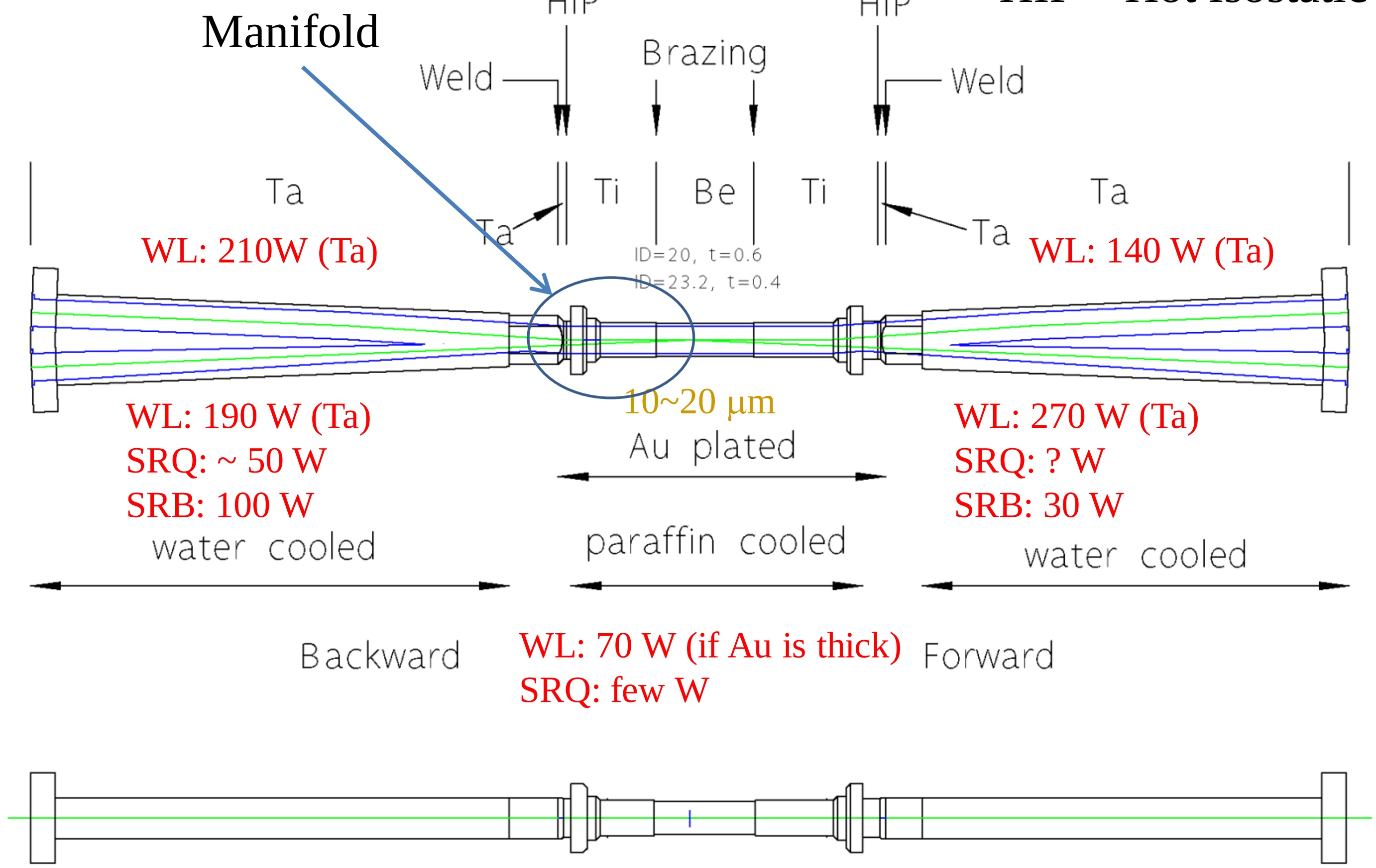
Risk for multiply scattered photon to escape forward

The loss factor of the shape with a vertical face is lower around a typical bunch length of 5 mm due to its fine structure. The shape of ridges will be redesigned to similar one shown in the upper figure.

The contribution of the tip scattering on the top of a ridge is experimentally studied by Z. Murakami and S. Tanaka. Its effect in SR shielding is not serious.

2. IP Chamber Material

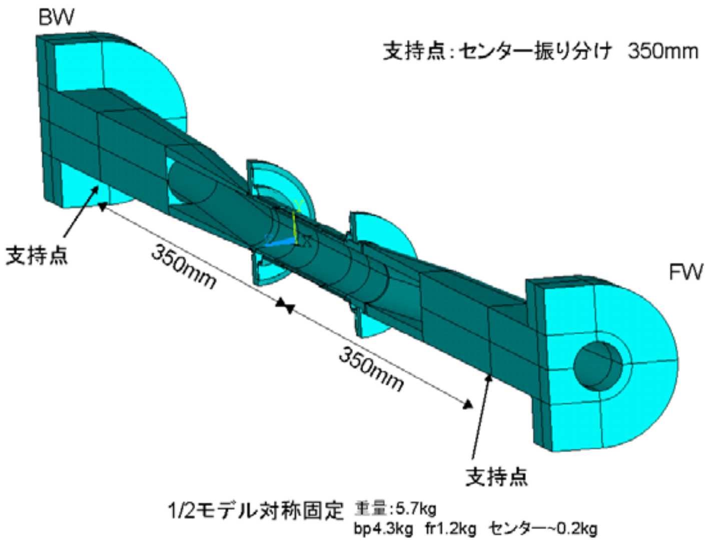
HIP = Hot Isostatic Pressing

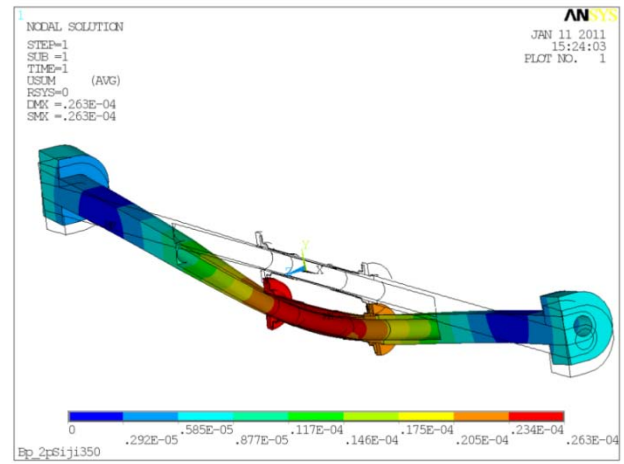


- The branching part is made of Ta (high Z material).
- Thin (1~2 μm) Au coat to reduce ohmic power loss on Ti and Ta is an option.

2. IP Chamber
Stress Analysis (2)

(Koike)





変位:Max 0.026mm

Results of stress analysis of the IP chamber

- Even if the chamber is horizontally supported at one end , the maximum stress in the Be part (157 MPa) is less than its yield strength (245 MPa). (It doesn't break!)
- If the chamber is supported at both ends, the central part bend down 0.44 mm, and the stress in the Be tube is 39 MPa.
- If the chamber is supported at the proper position of the Y-shaped part, the central part bend down only 0.026 mm (above picture), and the stress of Be pipe becomes as small as 3.5 MPa.

Therefore, though IP chamber has a delicate structure (Be part), it is not so weak as to require a help of a special supporting tool in handling.

2. IP Chamber
Summary of technological issues

	status	comment
Be-Ti brazing	Tested, OK	
Ti-Ta HIP	Tested, OK	
Ta EBW near HIP	Under testing	
Machining of ridges	Tested with Al, OK	
10~20 μm Au sputter plating for the central part of IR chamber	Under discussion with a company	To stop 5~20 keV photon
1~2 μm Au sputter coating on Ta and Ti		To reduce ohmic power loss To obtain a low PID surface (?)
Ta beam pipe	Under fabrication of a small model	(QCS)

<u>Advise on Au sputter coating is welcome.</u>

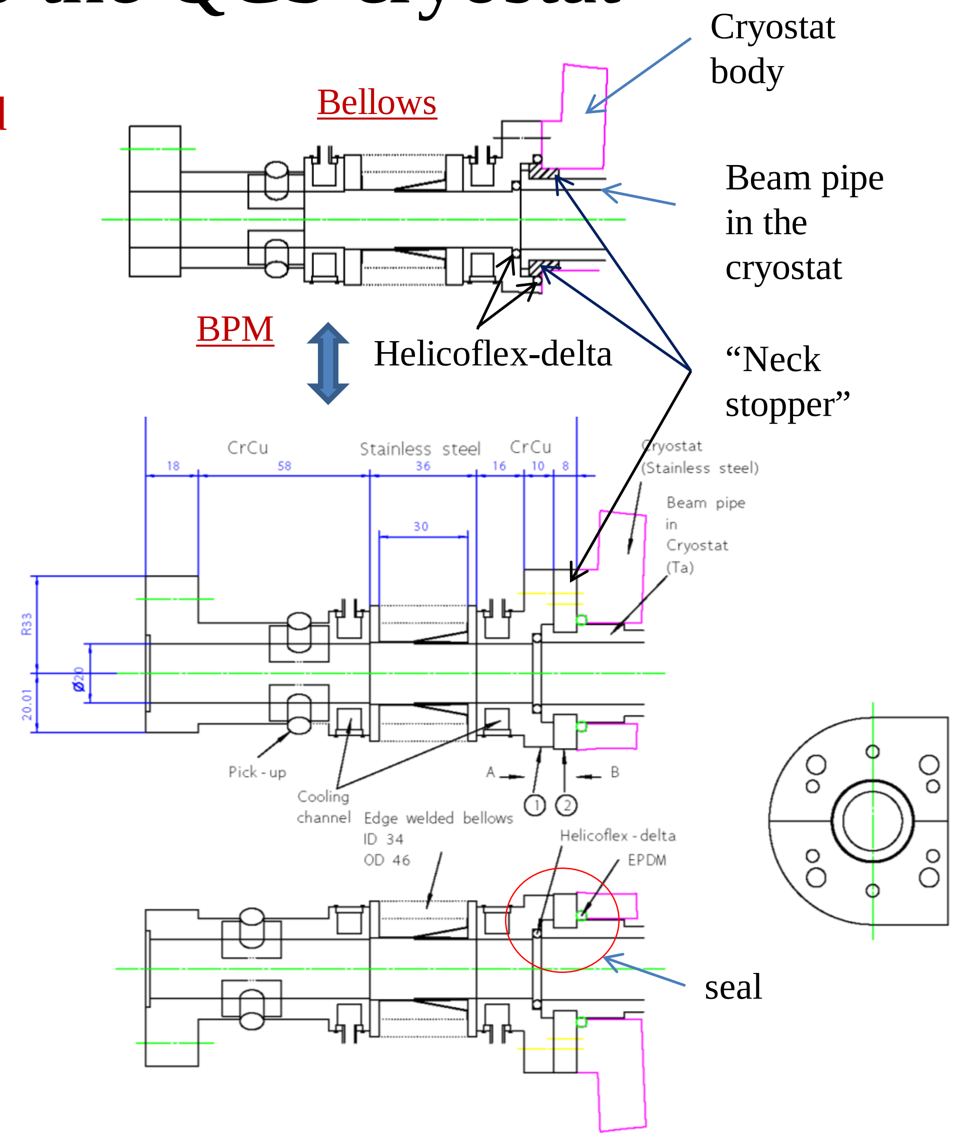
2. IP Chamber
Connection to the QCS cryostat

Important ingredients are bellows unit and BPM's.

•A model test of the original sealing mechanism was successfully done.

(Photo by Tanaka)

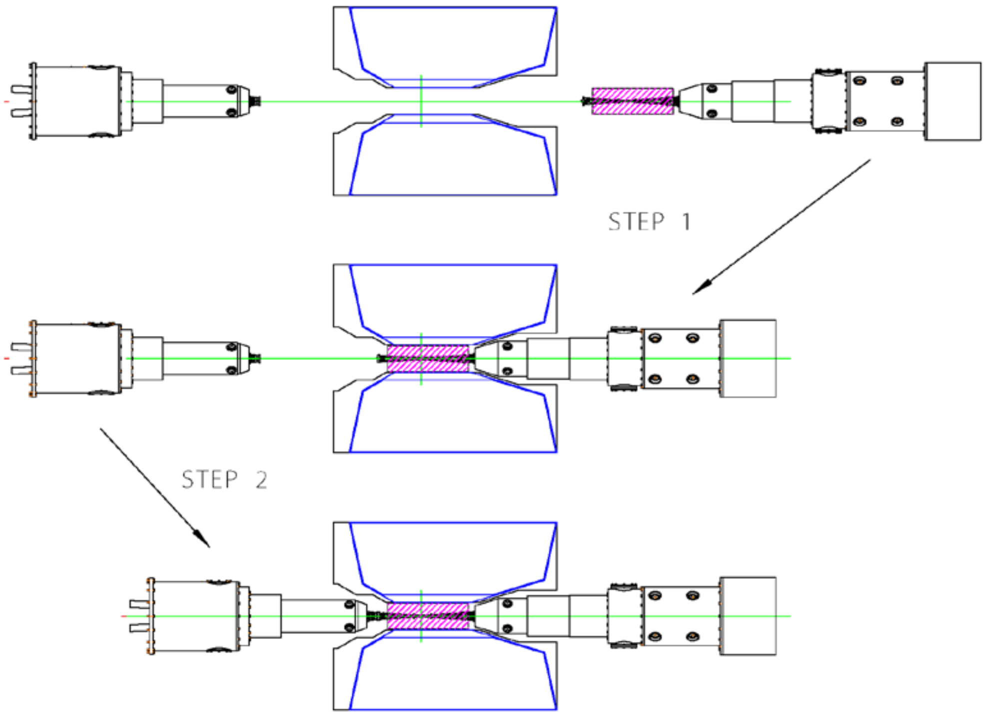
•The use of radiation hard elastomer (EPDM) is investigated as a seal for the insulation vacuum of the cryostat.
•This make it possible to keep the insulation vacuum of the cryostat in exchanging this connection pipe.
•This will be judged based on the estimation of radiation level at the seal.



3. Installation
Basic Steps

Top view

L-side R-side



1. Connect IP chamber with SVD4 to the QCSR cryostat.
2. The QCSR cryostat moves in. To support SVD4, a gutter is used.
3. The QCSL cryostat moves in.
4. Connect the flanges in front of the QCSL cryostat.

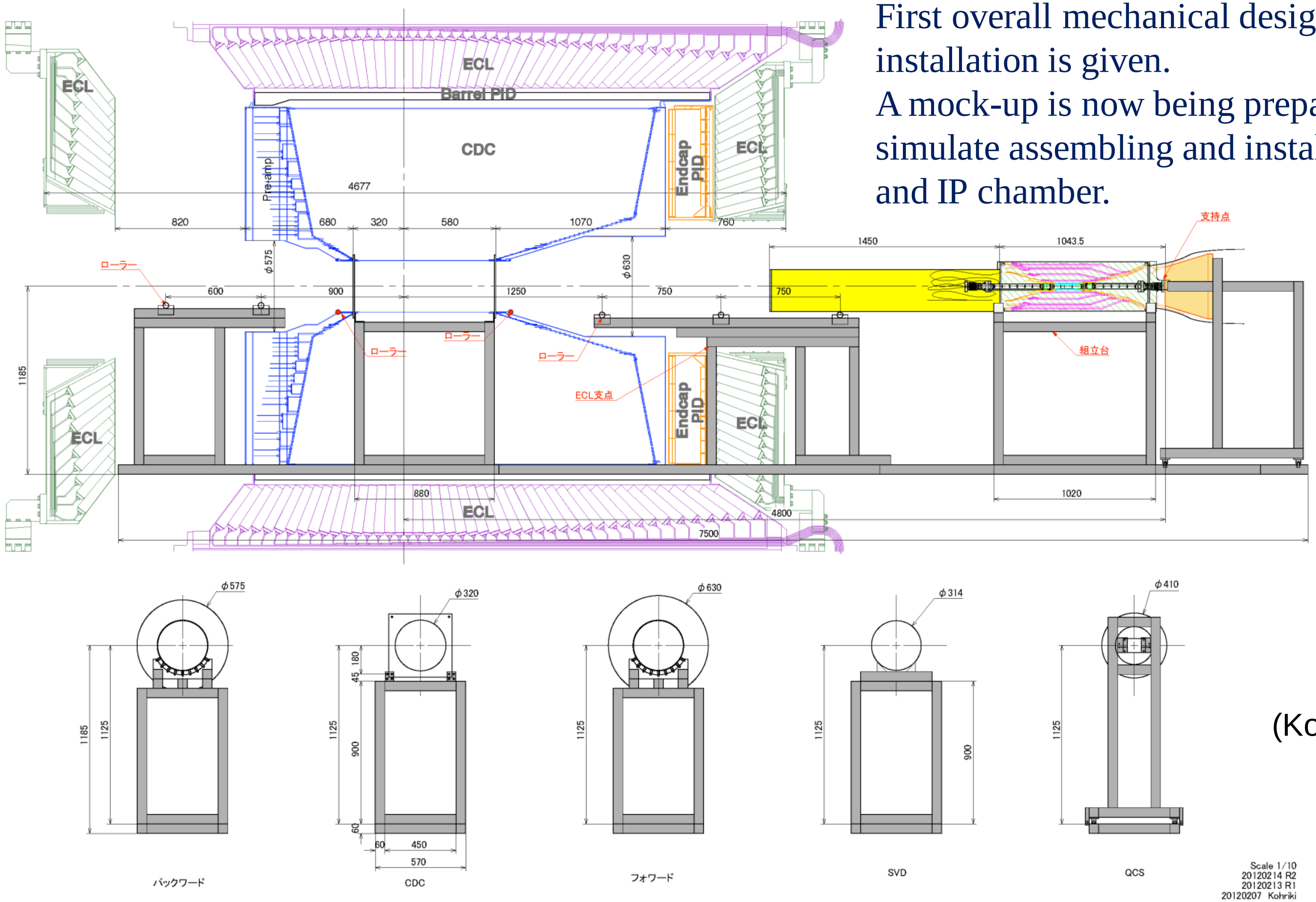
•Both sides of IP chamber are fixed to the SVD4 frame transversally and are free longitudinally.

•The R-side of SVD4 is aligned transversally and is free longitudinally.

•The L-side of SVD4 is fixed to CDC.

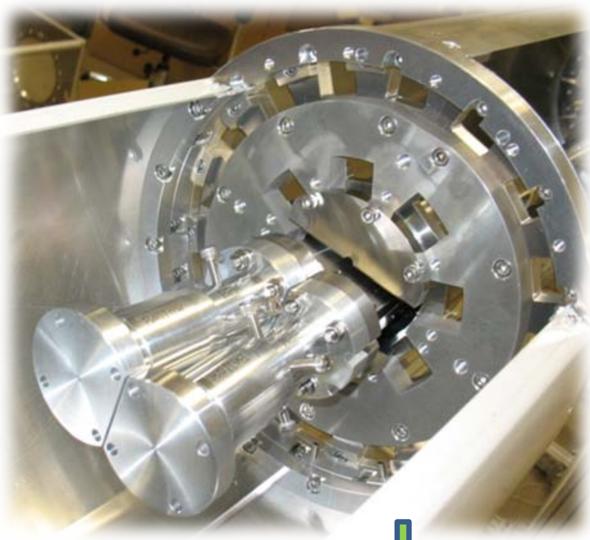
3. Installation
Mock-up for assembly simulation

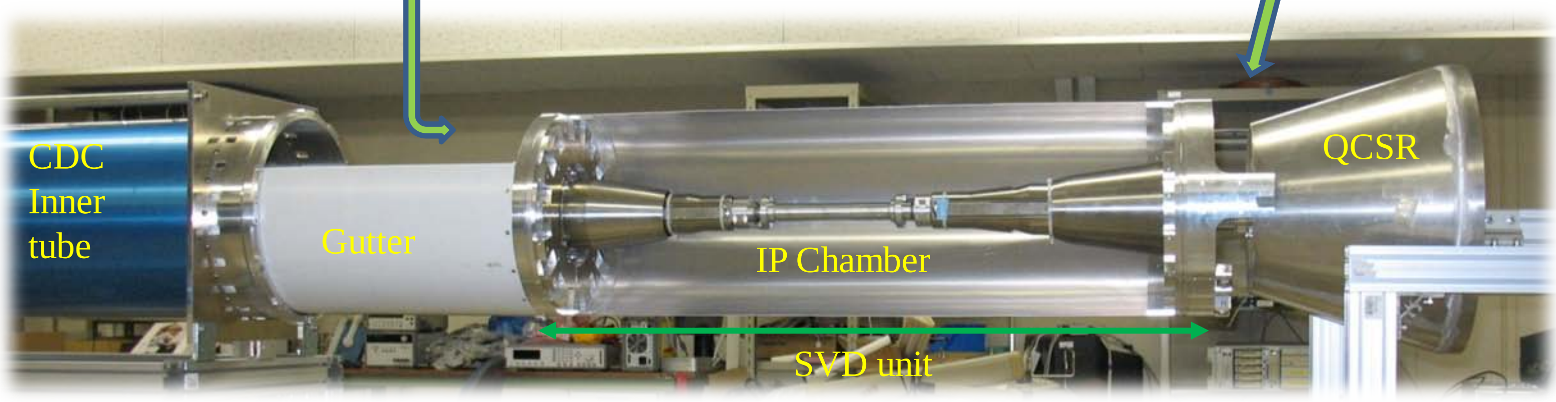
First overall mechanical design for the installation is given.
A mock-up is now being prepared to simulate assembling and installing of SVD and IP chamber.



(Kohriki)

3. Installation
Pictures of Mock-up at present





4. Summary

- Within ±3.8 m around IP, the major outgassing is due to photo-desorption process by the direct SR from the last bend, an idea to reduce the photo-desorption coefficient is now investigated.
- The design of the IP chamber is now in the almost final stage. Most of fabrication technology are tested. Au sputter coating is a remaining issue of great concern.
- Installation procedure is discussed in detail and ingenious mechanical designs are proposed. Mock-up to simulate assembling IR components based on the present mechanical design is being prepared.